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(19) (CA) **CANADIAN PATENT** (12)

(54) METHOD FOR DRILLING HARD MATERIAL

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No. OF CLAIMS 15

The present invention relates to improvements in drilling hard material, such as rock.

The invention more particularly relates to an improved drill head for use in drilling relatively large holes, and to a rock drill employing such an improved drill head.

The invention also relates a novel metod for use in drilling relatively large holes.

Several methods are now employed for drilling relatively large holes in hard material, such as rock. In drilling large vertical holes such as ventilation, escape and/or safety shafts in mines, a vertical pivot hole is often drilled first. A chipping drill is then passed upwardly, guided by the pilot hole, to enlarge it. To obtain a large enough hole, however, several costly and time consuming passes must be made using successively larger chipping drills. Even in soft rock, the method is expensive and it does not always work satisfactorily in harder rock.

To drill vertical holes, it is also known to provide a drill head on the end of a drill shaft, which head carries its own drive unit and drills down from the top toward the bottom. Such units however are relatively small and thus only small holes can be drilled.

Another method of drilling large vertical holes comprises first drilling a small pilot hole from the top down, and then pulling a large drilling head upwardly while guiding it by the pilot hole. The drilling head is pulled up by the drill shaft used to drill the pilot hole. The drilling head comprises a cylindrical base having substantially the size of the large hole to be drilled and carrying a plurality of grinding rolls on its upper face to grind away the rock as the base is rotated and raised by the drill shaft. This drilling method however

means of which the drill head is fixed to a drill shaft to be rotated thereby. The impact hammers are generally parallel with the mounting post and the drill shaft and are located at different radial distances from the mounting post. The hammers also project different distances from the support body with the hammer radially nearest to the mounting post projecting the farthest from the support body, the next radially nearest hammer projecting the next farthest, and so on to the hammer farthest radially from the post which projects the least from the support body.

As the drill head is pulled toward the rock surface by the drill shaft, the first impact hammer which is slightly offset from the mounting post and drill shaft and projects farthest from the support body contacts the rock surface first. On rotation and pulling of the drill head by the drill shaft, the first impact hammer when operated starts to carve out a shallow spiral path in the rock about, but spaced from, the drill shaft. The path is carved out by fragmenting the rock by direct impact from the hammer. The rock between the path and the drill shaft is simultaneously fragmented by shear as the hammer rotates. On continued forward motion of the drill head, the second impact hammer comes in contact with the rock face and begins to carve out a second shallow spiral path concentric with the first path but spaced outwardly therefrom. The second path is also carved out by fragmenting the rock by direct impact from the second hammer and the rock between the second path and the deeper first path is simultaneously fragmented by shear as the second hammer passes by.

Additional impact hammers can be employed to provide a hole of the required diameter. Because much of the rock in drilling the hole is removed by shear, much less power is needed

taken in connection with the accompanying drawings in which:

Fig. 1 is a cross-section view of a mine showing a first embodiment of drill unit according to the invention, in operation;

Fig. 2 is a detail view of the drill unit shown in Fig. 1;

of the housing 31. Suitable means are provided within the housing 31 of each hammer for moving the impact rod 33, and the attached head 37 in an impacting manner. While impact "hammers" has been the term employed, any suitable impacting tool for hard material could also be used.

The drilling head 1 has a fixed mounting post 45 extending from the one end 41 of housing 21 by means of which the drilling head 1 is connected, via a connector 47, to the end of the drill shaft 7. The mounting post 45 projects past the impact heads 37 on the impact hammers 23 and 27. The mounting post 45 is connected to the drill shaft 7 is such a manner that they are substantially axially aligned. The mounting post 45 is eccentrically mounted on the housing 21 so that it is closer to the first impact hammer 23 than to the second impact hammer 27. The second impact hammer 27 is approximately twice as far away from the post 45 as is the first impact hammer 23. Both hammers 23 and 27 are generally parallel to each other and to the post 45.

The first impact hammer 23 which is the closest to the post 45, is positioned to project slightly further past the one end 41 of the main housing 21 than the second impact hammer 27. The second impact hammer 27 preferably is tilted outwardly very slightly so that the upper end 35 of its cylindrical housing 31 is slightly farther away from the axis 51 of the mounting post 45 than its lower end 53 as shown in Fig. 3. Also, the two impact hammers 23 and 27 are also preferably tilted slightly in opposite directions so that the upper end 35 of each cylindrical hammer housing 31 leads the lower end 53 of the housing 31 as the drill head 1 is rotated in operation in the direction of arrow "A" as seen in Fig. 4.

A compressed air supply line 61, as seen in Fig. 3,

rock by impact. While forming the step 85, the rock material between the hammer 23 and the post 45 is sheared off to form a first roughly sloping surface 87 between the step 85 and the post 45. As the first hammer 23 works its way into the rock, the second hammer 27 comes into contact with the rock approximately out of phase with the first hammer 23. Having the second hammer 27 located diametrically opposite the first hammer 23 helps to balance the forces acting on the drill head. The second hammer 27, while also tracing a shallow spiral path, but of larger diameter than the first path, cuts a second outer step 89 in the rock, spaced from the first step 85 as shown in Figs. 3 and 5. This second step is also formed by fragmenting the rock by impact. In cutting the second step, the second hammer forms theouter wall 91 of the circular shaft 3 being drilled and also shears off the material between it and the higher inner step 85 to form a second roughly sloping surface 93 joining the two steps.

Since the second hammer 27 slopes outwardly slightly, its impact head 37 forms the shaft 3 large enough the receive the drill head 1. If needed, the drill head can be provided with a pair of spaced-apart rings 95 encircling the housing 21 and 31, as shown in Fig. 2, and fixed thereto. The rings are concentric about the post 45 and serve to retain the drill head 1 in position in the shaft 3 being drilled. The slight forward tilting of the hammers 23 and 27, in the direction of rotation of the drill head 1, provides a slight forward component of force in the desired direction to help fragment and dislodge rock.

The rock that is fragmented by the drill head both by impact and shearing falls down past the head 1 into the gallery

hammer 231 is opposite the fourth hammer 229 and slightly shorter. The fifth hammer 231 is adjacent the outer edge 237 of the drill head 203 and angled outwardly slightly so that the wall 239 of the tunnel 201 formed by the impact head 241 on hammer 231 is slightly outside the outer edge 237 of the drill head 203. The remaining hammers are substantially parallel to each other and to the longitudinal axis 243 of the tunnel 201.

As with impact hammers 23 and 27, each hammer 223 to 231 is operated by suitable impact motor means carried by the drill head 241. Each hammer is also rotated by suitable rotational means carried by the drill head. Power for the impact motor means and rotational means is supplied from the power unit 207 by suitable means. The power unit 207 is slowly advanced to move the drill head forwardly. As the drill head is moved forwardly and is rotated and as the hammers are operated, the first central hammer 123 drills the central pilot hole 235 by impact fragmentation. The other four drills 225, 227, 229 and 231 follow spaced-apart, shallow spiral pahs, each working into the rock to cut a step 245, 247, 249 and 251 respectively by impact fragmentation. The sloping surfaces 253, 255 and 257, between the steps, and the surface 259 between the inner step 245 and the central hammer 233, are formed by shear fragmentation of the rock between the steps as the hammers are operated.

The rock falls to the bottom from where it can be raked by a raker 261, moving past the sides of the drill head, and onto a conveyor 263 carried by power unit 207.

whereas the mounting post projects from another end of said support means which is opposite to said one end, one of said hammers being axially aligned with the mounting post.

6. A drill head as claimed in Claim 4 wherein the one impact hammer axially aligned with the mounting post projects the farthest from said other end of the support means.

7. A drill head as claimed in claim 6 including at least three impact hammers, the third impact hammer being located radially about twice as far from the one hammer as the second hammer is radially located from the one hammer, the third hammer projecting the least of the three hammers from the support means.

8. A drill head as claimed in claim 1, 4 and 7, including means on the support means for operating the impact hammers.

9. In a rock drill comprising (a) a drill shaft (b) a drill head connected to said drill shaft and (c) drive means for rotating and axially moving the drill shaft and the drill head connected thereto toward a front of hard material to be drilled, the improvement wherein said drill head comprising:

support means

a mounting post secured to and projecting from the support means

means for detachably connecting said mounting post to an end of the drill shaft in axial alignment therewith; and

at least two impact hammers mounted onto and projecting from said support means towards said front of hard material to be drilled, said hammers being located at a different radial distances from the mounting post and having rock-fragmenting heads disposed at different distances from the

15. A method as claimed in claim 13 wherein a small central guide hole is formed simultaneously with the large hole being drilled, the rock being fragmented by shear inwardly toward the guide hole.

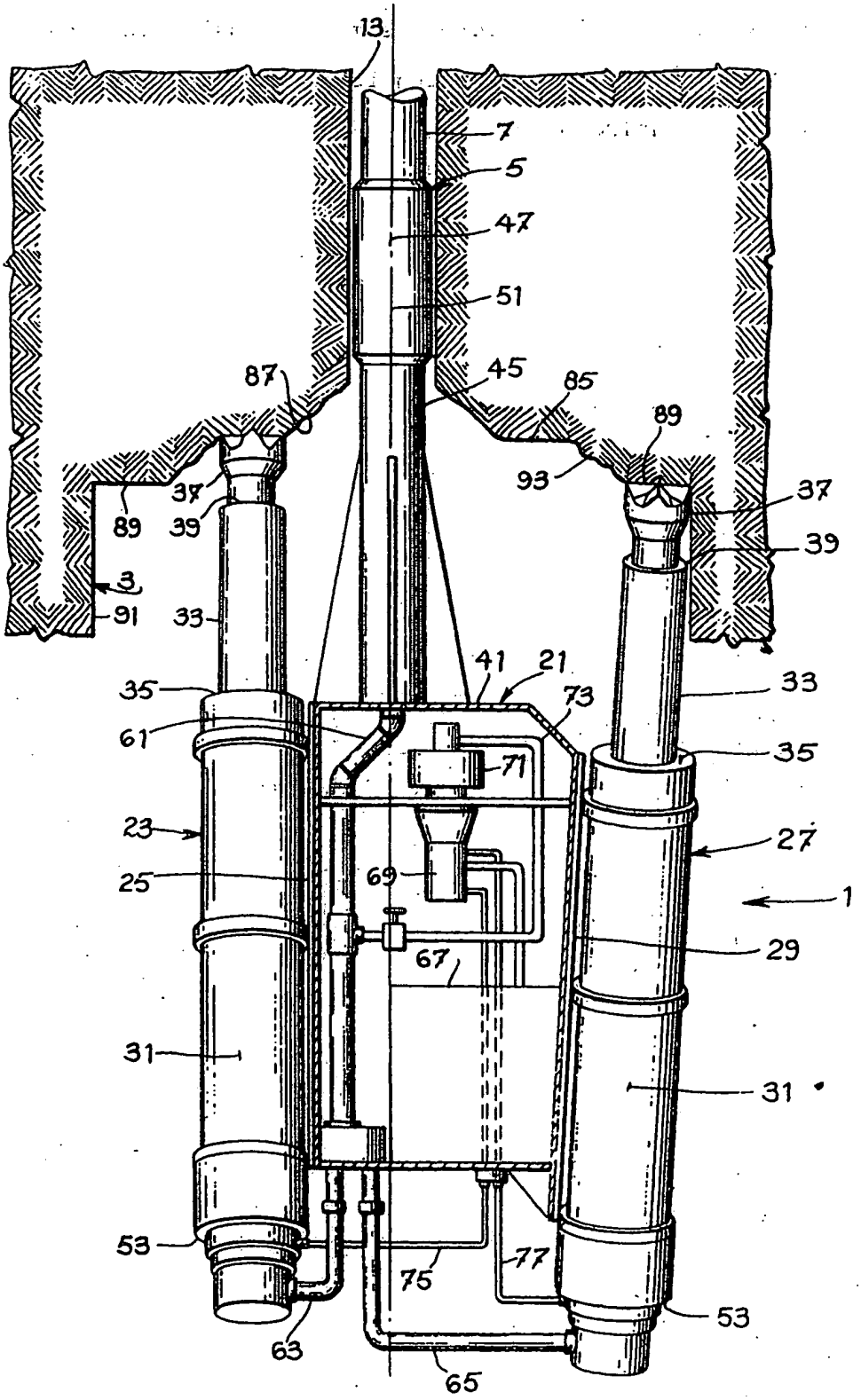
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FIG. 3

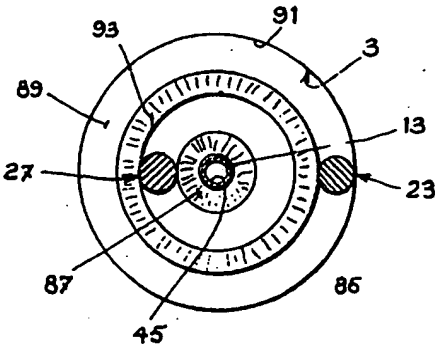
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Fig. 5

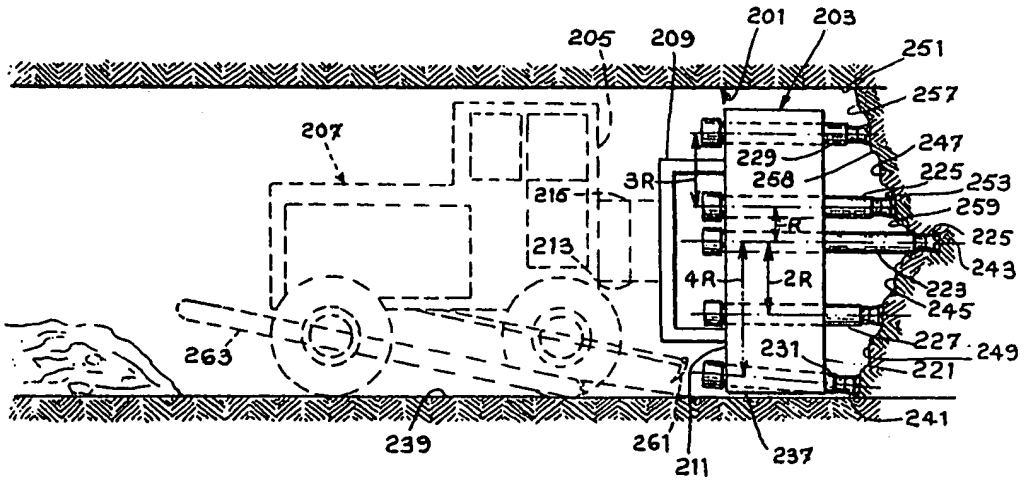
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Fig. 6